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ABSTRACT

This assessment, funded by the National Institute of Education, identifies factors which are related tc prcblems associated with women participating in mathematics. A review of the literature is given which identifies variables for investigation and instruments which exist. The development process is discussed. This includes survey development, editing items, and field testing survey materials. Future plans concerning the drawing cf the survey sample, the administration of the questicnnaire, and the scoring cf the survey are discussed. (SA)

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ANNUAL REPORT

September, 1978

A NATIONAL ASSESSMENT OF PERFORMANCE AND PARTICIPATION OF WOMEN IN MATHEMATICS

NIE Grant NIE-G-77-0061

Education Commission of the States
National Assessment of Educational Progress
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CHAPTER 1

Introduction

Overview of the Study

A National Assessment of the Performance and Participation of Women in Mathematics is a two-year project funded by the National Institute of Education. The purpose of the study is to identify the most salient factors related to the problem of women's participation in mathematics and to explore the interrelationships among suspected "causal" variables thereby guiding future research and intervention effects.

The survey study is being conducted by the National Assessment of Educational Progress (NAEP). NAEP is in a particularly advantageous position to conduct this study since it can be incorporated into the already-existing annual national survey. NAEP personnel and subcontractors experienced in conducting national surveys have been or will be involved in all aspects of the study including item development, field testing, final administration, analysis and reporting.

The first phase of the project, which began in October of 1977, was a review of the literature to identify the most promising variables to investigate and to locate existing instruments. During the first eight months of the project, a large number of consultants from various disciplines participated in the survey development by refining variable definitions; reviewing, selecting and editing items; and developing new items and item scales. Survey materials were field tested on two separate occasions using samples of approximately nine hundred each time. Eighth and eleventh or twelfth grade males and females comprised the field test samples. Item analysis and factor analysis of field test data were invaluable in developing the final survey instrument. Items included in the questionnaire fall in the following categories of variables: sex-role stereotyping, career and academic plans, self-concept in mathematics, school experience (especially in mathematics), student background information, influences of significant others (parents, peers, teachers and counselors) and mathematics achievement. The final variable list is found in Chapter 6.

The drawing of the survey sample and the administration of the questionnaire will be performed in the fall of 1978 by the Research Triangle Institute, Raleigh-Durham, North Carolina under subcontract to National Assessment. The survey questionnaire will be administered to thirteen hundred thirteen-year-olds and sixteen hundred high school seniors both males and females. Seniors taking advanced mathematics courses will be oversampled since they represent such a small proportion of the student population and since this group is of particular interest in this study.

Scoring of the survey will be performed by the Measurement Research Center, Iowa City, Iowa, and analyses of the results will be conducted by NAEP personnel using the computer facilities at NAEP. Final reports will be available in the fall of 1979.

Survey Rationale

The NAEP survey is a pre-paradigmatic approach for identifying potential variables for intervention. This approach can investigate a large

number of variables and by doing so identify areas in which small-scale experimental research would be most productive. Unfortunately, this first step toward determining intervention strategies is usually skipped. Many smaller studies have investigated aspects of the problem in question, yet as one might expect the results have been conflicting, though not necessarily inaccurate considering the special aspects of the samples involved. Furthermore, studies addressing a very limited number of possible causal factors constitute "piecemeal" probes into the nature of the problem. They cannot be expected to provide insight into the complex interrelationships of variables which, by now, we are sure exist. Thus, when it comes to the relative importance of different possible causal factors either across or within population subgroups, little is known. This is the kind of information a large survey can provide to make future research more useful and less "hit-or-miss." In addition to providing descriptive data on a large number of variables and identifying the "most promising," still more can be done with survey data to guide future research and intervention. Further analysis of the data can identify plausible hypotheses which merit more detailed study.

In summary, the survey model allows many variables to be explored while the research model allows a few variables to be explored in greater depth. The survey approach is particularly appropriate for a complex problem like that of female participation in mathematics where there are numerous plausible explanations. Furthermore, a national sample is the only way to resolve those conflicting research findings due to eccentric samples; and with the statistical power available from a large number of respondents, a large-scale survey can detect those stable but small influences that smaller studies are too insensitive to catch.

CHAPTER 2

Review of the Literature

Mathematical Performance

The existence of sex differences in mathematical achievement is generally acknowledged. National Assessment of Educational Progress (NAEP) and Fennema and Sherman (1976) have found that males out-perform females in mathematics at the high school level and beyond. Furthermore, studies have detected a trend for males to perform better on higher level cognitive tasks and for females to perform better at lower cognitive levels (Fennema, 1974a; Fennema and Sherman, 1976; National Longitudinal Study of Mathematical Abilities [NLSMA]).

Differential course-taking behavior seems to be a plausible explanation for sex differences in achievement. NAEP, which provided the most convincing evidence of male superiority in mathematics, did not control for the number and type of mathematics courses taken in the first assessment. There is little question that fewer females than males enroll in the more advanced courses. Enrollment statistics confirm this allegation (e.g., Wisconsin Department of Public Instruction, 1975-76). This study is intended to produce a better understanding of the underlying reasons for the differential course-taking of males and females.

Career Perceptions and Aspirations

A large number of studies have found distinct differences between the career interests of males and females of all ages (Looft, 1971; Schlossberg and Goodman, 1972; Iglitzen, 1972, 1973; Ory and Helfrich, 1976; Rossi, 1965; Astin, 1969, 1974; Smith, 1976; Hawley, 1971, 1972; Lipman-Blumen, 1975; Astin, Harway, Michele and McNamara, 1976). Much of the research points to role-modeling and sex-role identification as major influences on career expectations of women. Studies suggest that many females regard careers for themselves as incompatible with family responsibilities. Commitment of a woman to a professional career would interfere with homemaking, raising a family, the husband's success, and the happiness of a marriage. Even for women seeking jobs outside the home, these domestic responsibilities which they perceive as responsibilities of the female, seem to limit the career choices of females and, for many women, prevent any consideration of careers in mathematical or scientific fields (Rossi, 1965; Prediger, McClure and Noeth, 1976).

Attitudes--Oneself and Mathematics

The literature suggests there may be little difference between the general attitude toward mathematics of males and females in elementary and secondary schools (Aiken, 1970, 1976; Ernest, 1976; Fox, 1974, 1975b; Callahan, 1971). However, differences seem to be more pronounced at the college level, males showing a more positive general attitude (Aiken, 1972; Aiken and Dreger, 1961; Dreger and Aiken, 1957). At both the elementary and secondary levels, there appear to be no sex differences with respect to preferences for mathematics compared with other school subjects (Aiken, 1970, 1976; Ernest, 1976; Fox, 1974, 1975b).

Several studies indicate there may be differences between males and females with respect to such constructs as self-concept, confidence and anxiety in mathematics (Erlick and LeBold, 1975; Fennema and Sherman, 1976; Kaminski, Erickson, Ross and Bradfield, 1976; Ernest, 1976; Fennema, 1974b; Levine, 1976; Crandall et al., 1962; Tobias, 1976). There is a scarcity of information on sex differences in mathematics achievement motivation. It is assumed, however, that because many females seem to regard mathematics and careers in technical fields more appropriate for males, females will have less achievement motivation in mathematics.

Attitudes--Perceptions of Mathematics

Several studies have detected sex differences in the perceived usefulness of mathematics (Fennema and Sherman, 1976; Fox, 1975b; Hilton and Berglund, 1974; Sherman and Fennema, 1976). The research of Fennema ahd Sherman (1976) and Hilton and Berglund (1974) indicate the presence of a relationship between sex differences in achievement and perceptions of the usefulness of mathematics for making a living. Hilton and Berglund suggested that different male and female perceptions of the usefulness of mathematics result from sex-typing of mathematics and careers.

The sex-typing of mathematics has been a concern of several studies. Stein and Smithells (1969), Ernest (1976) and Fennema and Sherman (1976) showed that high school students perceived mathematics as a male domain. While the Sherman and Fennema (1976) study found that males perceived mathematics as a male domain more than females, there was a relationship between female achievement and female stereotyping of mathematics as a male domain. A plausible explanation of mathematics stereotyping which has been the focus of other studies is masculine identification (Carlsmith, 1964; Landy, Rosenberg and Sutton-Smith, 1969; Lynn, 1972; Elton and Rose, 1967; Milton, 1959). Other explanations point to the influence of significant others and role-modeling.

Significant Others

It seems reasonable that a student's attitudes toward and perceptions of mathematics, course-selection decisions, and mathematical achievement could be influenced by that student's interpretation of the attitudes, perceptions, expectations, abilities and behaviors of others.

Aiken (1975, 1976) and Maccoby and Jacklin (1974) suggest that sex differences in mathematical performance are related to same sex modeling. For example, girls model their behavior after mothers who tend to be more verbal than quantitative. Students' attitudes toward mathematics seem to be related to the students' perceptions of the attitudes and abilities of their parents (Poffenberger and Norton, 1959; Aiken, 1972). Sherman and Fennema (1976) found students' perceptions of their parents' attitudes to be related to the students' course-taking intentions. Parental expectations seem to influence students' success in mathematics (Poffenberger and Norton, 1956, 1959; Hill, 1967), and

parents do seem to have lesser expectations for daughters than for sons (Levine, 1976; Casserly, 1975).

A considerable amount of evidence suggests that girls are seriously concerned about negative consequences of academic success especially in mathematics (decreased popularity, disapproval of boys, etc.) and that their fears are well-founded (Horner, 1968; Solano, 1976; Casserly, 1975; Husbands, 1972; Farley, 1968; Coleman, 1961; Hawley, 1971, 1972; Komarovsky, 1946; Lavach and Lanier, 1975; Fox, 1974, 1975a, 1976b; Fennema and Sherman, 1976; Levine, 1976; Shapiro, 1962). Entwisle and Greenberger (1972) found that male peers actually exert pressure on girls whose career aspirations are still developing. They also found that attitudes toward career achievement of females were related to socioeconomic status. Such peer-related problems have caused some investigators to consider sex-segregation as an intervention strategy. However, a more acceptable approach would be early tracking of girls in more advanced programs (Casserly, 1975; Farley, 1968; Fox, 1975a).

The research literature indicates that counselors offer little encouragement for females to pursue mathematics or professional careers. Frequently, counselors have actually discouraged females in such pursuits and projected their own stereotypic beliefs (Haven, 1971; Casserly, 1975; Luchins, 1976; Perucci, 1970; Harway et al., 1976; Thomas and Steward, 1971).

There is some evidence that students' attitudes toward mathematics are related to experiences with teachers (Ernest, 1976; Haven, 1971; Poffenberger and Norton, 1956, 1959; Luchins, 1976; Casserly, 1975; Anderson, 1963). Ernest (1976) and Levine (1976) found that teachers had different expectations for girls; Solano (1976) and Fox (1974, 1975a) found that some teachers have negative opinions of mathematically-gifted females, and Sears and Feldman (1966) concluded that teachers reinforce sexually stereotypic behavior. Several studies have detected differential treatment of males and females by teachers (Bean, 1976; Good, Sikes, Brophy, 1973; Levy, 1972; Sanderson and Anderson, 1960; Stacey, Bereaud and Daniels, 1974).

Existing Instruments

The research literature on measuring attitudes toward mathematics is extensive. The best known comprehensive reviews were compiled by Aiken in 1970 and 1976. Early efforts to measure attitudes toward mathematics resulted in instruments yielding a single score for a person's general feeling for mathematics (e.g., Dutton, 1954; Aiken and Dreger, 1961). The Junior High School Attitude Inventory (Hoyt and MacEachern, 1958) and the Minnesota Pupil Opinions (also developed by Hoyt for an unpublished study in 1960), consisted of subinventories, but have been used most effectively when the scores of the various scales were combined. More recently, researchers, recognizing the complexity of attitudes, have developed multi-dimensional instruments focusing on such constructs as self-concept, confidence and anxiety as well as other aspects of attitude toward mathematics such as perceptions of the nature of mathematics and the usefulness of mathematics in society. The International

Study of Achievement in Mathematical Abilities (Romberg and Wilson, 1969) investigated such attitude subscales. Sandman (1972) constructed a multi-dimensional math attitude instrument and internally validated his six scales through factor analysis. He investigated the external validity of his scales by making regional and grade level comparisons and by comparing the results of his study with those of other studies.

These are only a few of the instruments located in the literature search for use in this study. A complete list of instruments is noted by asterisks in front of the references in the bibliography which include the instruments.

CHAPTER 3

The Development Process

Review of the Literature

Work on the project began immediately with a review of the literature. The first efforts were based on the Fox, Fennema and Sherman papers prepared for NIE.[1] Nearly all cited references in the Fox and Fennema papers were located and reviewed for important information pertaining to this study. Once the original references were located, bibliographies of these works were reviewed and more relevant articles located. In addition to this system of locating pertinent articles, an ERIC search was completed. The literature review provided two important sources of information: 1) a review of research on those factors (variables) which may be affecting women's participation in mathematics (this helped to identify the more important variables to be addressed in the survey), and 2) copies or sources of existing instruments to measure these variables.

Defining the Variables

After the literature review, a tentative list of variables was developed which attempted to categorize the variables into groups (such as mathematics and oneself, parents' influence, careers, stereotyping, etc.). Folders were prepared for each variable and included copies of relevant research articles and existing instruments. These were reviewed by staff, and definitions of each variable were drafted. A rough first draft of scales or individual items for each of the variables of interest was prepared. A complete description of the final survey variables appears in Chapter 4.

Review of the Variables and Instruments

A five-member advisory board was formed to give their reactions to products and plans and to advise the project staff. The board was comprised of three nationally known mathematics educators and two research psychologists. Their names and affiliations appear in Appendix A.

At several meetings of the advisory board, definitions were refined and existing instruments were reviewed for accuracy, completeness, item quality and content validity. The advisors aided the development process by noting areas where new items needed to be developed and recommending procedures for filling such gaps. After project staff and the advisory board agreed on the development which needed to be done, consultants were brought in on an individual basis to edit existing items and write new items to measure the variables as they had been defined. Names and affiliations of consultants who worked on this project also appear in Appendix A.

In February, 1978 all items and scales were field tested on approximately five hundred eighth graders and five hundred twelfth graders from Duluth, Minnesota and Columbus, Georgia. Both males and females

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[1] Women and Mathematics: Research Perspectives for Change, NIE Paper in Education and Work; No. 8, 1977.

were tested. These sites were selected to represent the national mean, based on NAEP's sampling plan. Related scales and items were packaged together resulting in two test booklets which were administered to both ages. For example, all the items measuring self confidence, anxiety, enjoyment and parental influence and encouragement were randomly included in the same package. This allowed the data to be analyzed by scales yielding inter-item as well as some inter-scale correlations. The LERTAP item analysis program and the SAS factor analysis program (principal components, with and without a varimax rotation) were used.[2] Items with low item-to-scale correlations and small standard deviations were eliminated. This technique was used to development short (ten to fifteen item) scales with high reliability.

Factor analysis was used to aid in the identification of separate variables ("factors") in the "Mathematics and Oneself" category. Items, both new and old, addressed such constructs as anxiety, enjoyment, confidence, self-concept and motivation in mathematics. Confidence in mathematics and self-concept as a learner loaded on one factor which was called "confidence." Motivation items were combined with enjoyment items. Anxiety and confidence, although highly correlated, were distinct factors. Therefore, the three "Mathematics and Oneself" scales used in the study relate to confidence, anxiety and enjoyment.

At another meeting, the advisory board reviewed the results of field testing and made recommendations for the inclusion of items in final scales based on: 1) a high item to scale correlation for both ages and both sexes (to increase scale reliability), and 2) a high standard deviation (indicating variability in responses) for both ages and both sexes. Differences between item means for different groups were <u>not</u> used as a basis for item selection.

These selection criteria did not take into account the "polarity" or direction of the response for items in scales. Classically, scales have as many positive items as negative items to prevent the respondent from getting into a response set when answering items in scales. During development, many items with good psychometric qualities were rewritten into a positive or negative direction to balance the number of positive or negative items within a scale. When the new version was field tested, the item to scale correlations may have been significantly lower, thus changing the scale reliability. Final selection of items for scales depended more on the contribution of each item to the scale than on polarity. Thus, some scales are not balanced with respect to the polarity of items. However, the response set problem is not a threat in this study since items from many scales were packaged together randomly, and items with both positive and negative polarity were well-represented.

Again, consultants were brought in to review the selected items and fill in gaps where items had been deleted or refinements in the definition

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[2] LERTAP (Laboratory of Educational Research Test Analysis Package) is an item analysis program written by Larry R. Nelson, University of Colorado, Boulder. SAS (Statistical Analysis System) is from the SAS Institute, Raleigh, North Carolina, 1976.

of the variable had been made. In April of 1978, the instruments were again field tested, this time on nine hundred eighth and eleventh graders in Minnesota, Rhode Island and Connecticut. As in the first field testing, items measuring the same variable and scales in the same categories were packaged in the same booklet.

Following the April field tests, items were again analyzed by LERTAP and the weaker items (based on item-to-scale correlations and standard deviations) were rejected. Also at this stage, items were rejected if they were repetitious. For example, the difference between two particular items may have been relatively minor (due to slight variations in wording). By testing both, the more effective of the two items could be identified. Logical analysis also entered into the final selection of items in that consultants, staff and advisory board members wanted to be sure various aspects of variables were represented in the scales. For example, anxiety when in class, when taking tests and when doing mathematics would be components of anxiety toward mathematics and were included in the final scale.

Validation

A small validation study was conducted in local Denver schools during May of 1978. Teacher ratings of students were correlated with students' scale scores on three variables. Six teachers (junior and senior high school) were asked to rate the students in two or three of their mathematics classes (ranging from general mathematics to geometry) using a five point scale for the variables of enjoyment, anxiety and confidence. Students responded to a brief questionnaire which included the items from these scales. Correlations between teacher ratings and student scores ranged from .39 to .70 for confidence, .26 to .50 for anxiety and .20 to .61 for enjoyment.

Instruments measuring other variables were not validated using the above approach because 1) they attempted to measure a student's perceptions of such things as parental encouragement where the perception is more important than reality, or 2) the items were background questions concerning such things as parental education or occupations. However, additional validation work will be done on survey instruments during the fall of 1978.

CHAPTER 4

Definition of Variables

Introduction

This chapter describes the variables of interest in this study. It gives conceptual definitions, more detailed descriptions of items measuring variables, "components" of constructs being investigated and rationale for the selection of variables.

I. Sex-Role Stereotyping

A. General Sex-Role Stereotyping

It seems logical that females with "traditional" views about sex roles, would not perceive mathematics as being very useful in their future adult lives. Consequently, they would be less likely to enroll in advanced mathematics courses than more "contemporary" females or males.

This scale places respondents on a contemporary/traditional continuum with respect to their attitudes toward sex roles. Likert-type items address three different components of sex-role stereotyping:

1. Dual role of women. Items ask respondents' opinions about whether women can have successful careers and raise families at the same time.

2. Spousal responsibilities. Items measure attitudes about who should be responsible for the housekeeping and raising the children.

3. Equality of the sexes. Should women have the same opportunities and rewards in life as men, and do men and women have the same abilities?

B. Mathematics as a Male Domain

Although this variable may be a component of general sex-role stereotyping, it is mathematics-specific and treated as a separate variable in this study. Being "mathematics-specific," this variable could have a more "direct" influence than general sex-role stereotyping on female course-taking and achievement. This is clearly suggested by the research literature. Significant others investigated in this study (parents, teachers, counselors, peers and siblings) could certainly have a large influence (direct or indirect) on a student's stereotyping of mathematics or general sex-role stereotyping. Likert-type items in this scale measure the extent to which respondents regard mathematics as more appropriate for males than for females and deal with the following topics:

1. The comparative natural abilities of males and females in doing mathematics and in careers using mathematics.

2. The "masculinity" of women who pursue or who are good in mathematics.

3. The comparative need of males and females for a knowledge of mathematics.

C. Men's Attitudes Toward Women Who Are Successful in Mathematics

Researchers have suggested that women's opinions concerning the femininity of females who are successful in mathematics is not nearly as important as what they think men believe. Thus, the "social consequences" of success in mathematics and appeal to men are the real issues and the subjects of the Likert items in this scale. Female scores on this scale will provide an indication of the level of concern females have for this problem and how it relates to mathematics course taking. Male responses should reveal the extent to which women's concerns are justified.

II. Career Plans

A. Career Aspirations

This variable will be measured by an item which asks the student to select the occupational category which would include the job he or she hopes to have as an adult. (The same categories will be used to ascertain the father's occupation and the mother's occupation, an important factor for determining socioeconomic status.) Career aspirations seem to be an important link in the chain of variables leading to course-taking and achievement. This item could separate career-oriented from home-maker-oriented females, and the results should be consistent with sex-role stereotyping measures. For males or females, career choice should certainly relate to their perceived usefulness of mathematics for a career or for the academic preparation required for a career.

B. Mathematics Preparation Required for Job

While career aspirations should logically relate to mathematics course-taking, the more directly related variable would be the student's perception (accurate or not) of the amount of mathematics required for his or her chosen career. Consequently, a single item measures this variable by asking the respondents how much mathematics preparation is needed to get into their chosen careers.

C. Factors Influencing Career Choice

The respondents are asked to indicate how important each of eleven factors will be in making their choices of careers. This set of items is intended to directly determine the relative importance of many of the factors which the rest of the survey questions address individually (e.g., mother, father, teacher, counselor, amount of mathematics needed, and others). Two additional items measure the effects that the knowledge that a job 1) requires the use of mathematics, or 2) is traditionally done by members of the opposite sex,

would have on respondents' decisions about taking such jobs. These two items not only measure the importance of these two factors, but also the "direction" of influence of each.

III. Mathematics and Oneself

Most of the existing mathematics-specific affective instruments deal with one's perception of oneself in relation to mathematics. Earlier instruments were frequently multi-dimensional, representing several constructs. Items, though they may have been statistically "scalable", were of questionable quality for other reasons. For example, they may have lacked content validity in that frequently they did not address the construct intended; or in the case of some Likert scales, the statements were often compound sentences making it unclear what it was with which respondents were agreeing or disagreeing. More recent work in affective measurement in mathematics has resulted in uni-dimensional scales measuring such things as self-concept, confidence, anxiety, enjoyment, motivation and usefulness. Existing instruments have been a valuable item source for this project. Factor analysis of tryout data was used to help identify factors within the Mathematics and Oneself category. The three independent factors that emerged are confidence, anxiety and enjoyment. Although scales measuring motivation in mathematics are frequently included in batteries of affective instruments in mathematics, the present study does not include one. In a sense, the entire study is about motivation in mathematics. Not only is information being gathered about respondents' intentions to take more mathematics, but also the factors which motivate them are being studied.

The popular press has given a great deal of attention to "math anxiety", "mathophobia" and "math avoidance." Many institutions have established "clinics" for its treatment. The literature suggests there is strong relationship between confidence in mathematics and course participation, and that this relationship is different for the two sexes (i.e., males and females with a lot of confidence in mathematics tend to take more mathematics as do males with moderate confidence, but girls with only moderate confidence do not).

Previous research found sex differences in the expressed liking of mathematics at the college level, but generally not during the pre-college years. Nevertheless, enjoyment of mathematics could be like confidence and show different patterns of influence on participation within sexes.

A. Confidence in Mathematics

Likert items in this scale measure students' perceptions of how good and confident they are in mathematics or whether they have the potential to be good in mathematics.

B. Anxiety in Mathematics

Items in this scale deal with students' feelings of uneasiness doing mathematics, taking tests in mathematics class, and with feelings of anxiety toward mathematics in general.

In order to differentiate between students who are generally anxious and those whose anxiety is mathematics-specific, "parallel" scales have been developed for Anxiety in School and Anxiety in English. Similar scales could have been developed for confidence and enjoyment; however, considering the purpose of the study and time limitations for the administration of the final instrument, it was decided that "additional" anxiety scales would be sufficient.

C. Enjoyment of Mathematics

This scale includes items on students' enjoyment of mathematics in general, doing mathematics and mathematics class. Some items deal with students' desire to do more mathematics than is required or with their satisfaction in solving difficult problems.

IV. Usefulness of Mathematics to the Individual

Originally the usefulness category included three scales--Usefulness to the Individual, Usefulness to Others and Usefulness in Solving Societal Problems. However, for the purposes of this study, only usefulness to the individual (the respondents themselves) seems important. The research literature suggests that there are major differences between the sexes with respect to the perceived usefulness of mathematics, and this variable is strongly related to course-taking. Likert items in this scale address two components of usefulness: 1) Usefulness in daily life, and 2) Usefulness to career and educational plans.

V. Academic Plans

A. Educational Aspirations

One item asks the student the highest level of education he or she expects to complete.

B. Taking More Mathematics

One item asks thirteen-year-olds how many years of mathematics they plan to take in high school. Course names were not used in this item because many thirteen-year-olds would not know what they meant. Since thirteen-year-olds have had little choice regarding course-taking decisions, this variable could be as important a dependent variable for the study as past course participation is for the high school seniors.

Clearly, the two variables above would be influenced by respondents' career aspirations, and the second one, intent to take more math, could be, in part, a result of one's perceptions of the usefulness of mathematics. Regardless of one's career aspirations, a desire to go to college could be a reason to take mathematics courses in high school.

C. Factors Influencing the Decision to Take More Mathematics

A set of items for thirteen-year-olds ask them to indicate how important each of nine factors will be in making decisions about taking more mathematics courses. A similar set of items for seniors asks how important the same nine factors were in making decisions about taking mathematics courses in high school. These items, like those on Factors Influencing Career Choice, are intended to directly measure the relative importance of many of the factors which the rest of the survey exercises address individually (e.g., parents, teachers, usefulness, etc.).

VI. Parental Influences (Mother and Father Separately)

Significant others have a tremendous influence on children. Research suggests that this influence extends to a child's course-taking and achievement in mathematics and career aspirations via modeling, direct encouragement and expression of attitudes toward mathematics. In order of importance (greatest to least) based on the literature, the significant others are parents, peers, teachers and counselors. Items in this and the next variable category measure the students' perceptions of various attitudes, abilities and behaviors of significant others. In the parents category there are separate but parallel items and item scales pertaining to mothers and fathers. Parents can influence offspring in many ways. These items are intended to determine which parental influences seem to be most important and to determine the nature of interactions between these influences, sex of parent and sex of offspring.

A. Parents as Role Models

The items in these two scales deal with mothers' and fathers' feelings toward, abilities in and use of mathematics. They measure a form of "passive" influence, the results of the examples the parents themselves set.

B. Parents' Encouragement in Mathematics

These scales measure students' perceptions regarding active encouragement given them by their mothers and fathers and their parents' opinions of the students as learners of mathematics. In this study, a clear distinction is made between role modeling and "active" encouragement. It is assumed that even if a parent has very limited abilities in mathematics,

he or she can still exert a strong positive influence on offspring through direct encouragement. Frequently in previous research, this distinction has not been made.

C. Parents' Stereotyping of Mathematics

Single items determine whether or not respondents believe their parents think mathematics is "more for males than for females." These items parallel others in the Peer Influence Teacher Encouragement and Mathematics as a Male Domain scales.

D. Parents Helping with Homework

A single item determines which parent helps the student most (if at all) with mathematics homework.

E. Parents' Educational Expectations for Offspring

These items ask the respondents to indicate the highest level of education each parent expects them to complete. The levels of education from which the students can choose are identical to those in the item measuring the students' own educational aspirations.

F. Family Status

One would definitely expect different patterns of parental influence to be reflected in survey results for students from single-parent families. So that family status can be controlled, a question has been included in the survey which determines if a respondent lives with both parents (or guardians) or just one parent--mother or father. An additional question asks students who live with just one parent if they see the other parent often, indicating an opportunity for influence.

VII. Influences of Significant Others

A. Peer Influence

The lower participation of females in mathematics is sometimes attributed to the desire for social acceptance. Do students perceive being good in mathematics as being detrimental to one's relationship with peers? This appears to be a particular problem for females and would probably be closely associated with stereotyping of mathematics as a male domain. This scale does not deal with the femininity of women who take mathematics, but rather deals with what one's friends think about people who are good in mathematics, whether one tries to hide one's success in mathematics or whether one tries to avoid success in mathematics altogether. These are related to Horner's notions of fear of success or motivation to avoid success.

B. Peer Stereotyping of Mathematics

Two items in this category parallel items described in the parents' section. They ask the respondents whether the boys and girls among their friends think mathematics is more for males than for females.

C. Counselor Encouragement to Take More Mathematics (Twelfth Grade Only)

The one item in this category measures the extent to which a school counselor has encouraged or discouraged the respondent to take more mathematics.

D. Teacher Encouragement in Mathematics

Items in this scale deal with students' perceptions regarding direct encouragement given them by their teachers and teachers' opinions of the students as learners of mathematics. Many of these items parallel those in the Parental Encouragement category.

E. Teacher Stereotyping of Mathematics

The stereotyping item described earlier has been modified to apply to the respondent's perception of mathematics teachers' attitudes--whether mathematics teachers think mathematics is more for males than for females. This item is also in the Teacher Differential Treatment scale.

F. Teacher Differential Treatment

A great deal of research suggests that teachers behave differently toward male students than toward female students. Some kinds of differential expectations, encouragement and reinforcement of males versus females could be detrimental to the achievement, confidence and future mathematics participation of students of one sex. Items in this category address these three aspects of teacher behavior.

G. Sibling Role Models

Two items determine whether or not a respondent has an older brother or sister who is good in mathematics.

VIII. School Experience

A. Mathematics Participation (Course-Taking)

This variable may well be the most important dependent variable in the study. A series of questions determines which mathematics courses twelfth graders have taken or are taking. Information from these questions will be used to generate a Mathematics Participation "score" for each subject to be used in certain analyses. The same information will be a basis for sorting individuals into high, medium and low mathematics participation groups for other analyses. Students in both

age groups are asked to indicate whether or not they took (or are presently taking) Algebra I in the eighth grade.

B. Type of School Program

Twelfth graders are asked whether the emphasis of their high school courses is general, vocational or college preparatory.

C. Grades in Mathematics

A single item asks respondents to indicate which of five grade categories best describes the grades they have gotten in mathematics.

IX. Achievement in Mathematics

The scales in this category listed below consist of items from the existing instruments indicated.[3] Performance on these scales will be investigated separately, but for some analyses a composite mathematics achievement score will be used, probably based on the first three scales only.

A. Computation--Stanford Achievement Test

B. Algebra--Cooperative Algebra I

C. Problem Solving--Metropolitan Achievement Tests

D. Spatial Visualization--Revised Minnesota Paper Form Board

X. Background Variables

A. Sex

B. Age

C. Race

D. Socioeconomic Status (SES)

SES will be determined by a combination of factors--education of family head, occupation of family head and items in the home (e.g., televisions, magazines, etc.). Mothers' and fathers' education levels and occupations will be treated as separate variables also since they constitute two additional forms of parental influence.

E. Parental Education

F. Parental Occupations

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[3]See Appendix B for a complete source documentation of the cognitive items.

CHAPTER 5

Analysis Plans

Analysis Rationale--Myths about Sex Differences

Reviews of the literature in the area of women and mathematics have frequently cited studies which were not really investigating sex differences in course-taking or achievement, but rather, were looking for sex differences with respect to constructs such as anxiety in or enjoyment of mathematics. Such constructs were the dependent variables in those studies, and group differences are important if one's concern is reducing anxiety or enhancing enjoyment. Unfortunately, studies investigating causes of sex differences in mathematics course-taking have also sought sex differences in suspected causal factors. Sex differences in a particular variable do not provide even the slightest hint as to whether or not that variable is related to the lower participation of women in mathematics! What is important is the relationship of the variable to differential course-taking whether or not there are sex differences with respect to that variable. Reviews of the literature frequently make statements such as, "Researchers X and Y found no sex differences on variable Z." While the statement may be completely accurate, the implication is often made that one should dismiss that variable as not being related to the problem or that a sex difference exists--the studies just did not find it. Other studies have found that sex differences in course-taking were "accompanied by" sex differences with respect to other factors. Again, such statements constitute accurate reporting until conclusions about causation are drawn.

The argument that sex differences in potential causal variables do not necessarily relate to sex differences in course-taking is logically obvious and needs no empirical support, although it would not be difficult to find such evidence. One could certainly show that sex differences in course-taking are "accompanied by" differences in the average weights of males and females. Does this suggest that high caloric diets for females would solve the problem? Sex differences with respect to weight suggest that weight is correlated with sex, not course-taking.

Now the question becomes, "Once a variable has been shown to be related to course-taking, then are sex differences important?" Even if correlations exist between a "suspected" causal variable and course-taking for one or more than one group, differences between the groups on that variable are not necessary for one to conclude that the variable might in some way be related to the course-taking differences. Parents' abilities and backgrounds exemplify classes of variables which could have means for male and female students which do not differ but which could have differential influences on the two groups. Furthermore, the correlation of a variable with course-taking for females is in no way related to the male distributions on the two variables being correlated. Thus, if such a female correlation is high, a potentially important area for intervention may have been identified whether or not the male correlation is of a similar magnitude and whether or not the female mean on the "causal" variable is greater than, less than or equal to the male mean.

A proportion of the difference between two groups with respect to a dependent variable (e.g., course-taking) cannot be attributed to a particular variable. Many variables are related to mathematics course-taking for males, many for females; and the two lists are not identical. Thus, not only could the importance of a particular variable be different for the two sexes, the interactions between it and other variables would be different for the two groups as well. In other words, variables can "act differently" for different groups. Maternal employment, for example, would not have the same effect on males as on females. Sex-role stereotyping scales and scales dealing with mathematics as a "male domain" are somewhat threatening to females and not males because they deal with attitudes about whether females can fill male roles. Males in females roles is just not an issue in regard to mathematics.

The field tests for this study found some variables for which there were no sex differences; yet for females (and not males), these variables were significantly correlated with mathematics course-taking (educationally as well as statistically). Such factors are important. These results would be expected if one accepts the popular notion that social factors exist which, in effect, say that males should study mathematics and women should not. We know that regardless of ability, boys are going to take more mathematics than girls, and only the more able girls pursue mathematics. Maybe what is true for ability is also true for anxiety, enjoyment of mathematics, parental encouragement, etc. Boys, no matter how anxious they are about mathematics, are going to take more mathematics. Thus, the social influences mentioned above could make all those other factors unimportant. Yet for females, because the social influences discourage them from pursuing mathematics, those same "other factors" take on much more importance.

Analysis of the Survey Results

One of the objectives of the NAEP project is to provide descriptive statistics on a large number of variables supposedly related to the women in mathematics problem. In the previous section, however, it was pointed out that sex differences in independent variables do not necessarily account for sex differences in the dependent variable. Nevertheless, once more information is known about the causal factors, the descriptive statistics the survey will provide become important to researchers and policy makers for the normative information they furnish. Consequently, performance on measures of many variables for subgroups based on sex, race, age, socioeconomic status and possible combinations of these will be provided. Also, levels of mathematics course-taking will be used as a factor in subgroup comparisons. Stratifying on mathematics participation (the major dependent variable) will be helpful in identifying important "causal" factors. However, this strategy still isolates each potential causal variable providing only "piecemeal" information. The major contribution of the NAEP survey will be some knowledge of the relative importance of causal factors and the relationships among them. For example, parental influences will undoubtedly

prove to be an important factor related to sex differences in mathematics course-taking. Many other factors might seem relatively unimportant. Thus, one might conclude there is little hope in solving the problem in question since parental influences are not as open to intervention. However, if parents' effects on student course-taking are primarily indirect, mediated by several "lesser" factors which are intervenable, such as anxiety, perceived usefulness of mathematics, etc., then parental influences can be altered. Social factors leading to sex-role stereotyping on the part of students could well operate in a similar manner as parental influences. Thus, a most important aspect of the survey analysis will be the exploratory analyses examining such relationships. (Such analyses could include step-wise multiple regression analysis, path analysis or balancing.) The discussion earlier of sex differences and different patterns of influence of variables on different groups leads to an important implication for analysis. Namely, it is most important to examine the interrelationships of many variables within groups, not to make comparisons between groups with respect to variables taken individually.

CHAPTER 6

Instruments

Overview

This chapter includes the final list of the variables whichare included in this study, as well as the instruments organized by scales. The numbers in parentheses after each item indicate its package location in the survey instrument. For both ages, the survey instrument was divided into ten sections.

I. Attitudes
II. Mathematics Background
III. More Attitudes
IV. Computation
V. Problem Solving
VI. Parents' Attitudes
VII. Algebra
VIII. Teachers' and Friends' Attitudes
IX. Space Relations
X. Careers

Items administered to both ages have the same package location.

Where sets of items are intended to be used as scales, Hoyt reliability coefficients based on Phase II field testing data, are indicated.

The cognitive items (computation, problem solving, algebra, space relations) are not included in this section since they were secured from standardized tests and used by permission. Source documentation for cognitive items appears in Appendix C.

Final scale reliabilities will be reported based on the national survey results.

Outline of Variables

I. Sex-Role Stereotyping

- A. General Sex-Role Stereotyping
- B. Mathematics as a Male Domain
- C. Men's Attitudes Toward Women Who Are Successful in Mathematics

II. Career Plans

- A. Career Aspirations
- B. Mathematics Preparation Required for a Job
- C. Factors Influencing Career Choice

III. Mathematics and Oneself

- A. Confidence in Mathematics
- B. Anxiety in Mathematics, School, English
- C. Enjoyment of Mathematics

IV. Usefulness of Mathematics to the Individual

V. Academic Plans

- A. Educational Aspirations
- B. Taking More Mathematics
- C. Factors Influencing the Decision to Take More Mathematics

VI. Parental Influences (Mother and Father Separately)

- A. Parents as Role Models
- B. Parents' Encouragement in Mathematics
- C. Parents' Stereotyping of Mathematics
- D. Parents Helping with Homework
- E. Parents' Educational Expectations for Offspring
- F. Family Status

VII. Influences of Significant Others

- A. Peer Influence
- B. Peer Stereotyping of Mathematics
- C. Counselor Encouragement to Take More Mathematics
- D. Teacher Encouragement in Mathematics
- E. Teacher Stereotyping of Mathematics
- F. Teacher Differential Treatment
- G. Sibling Role Models

VIII. School Experience

- A. Mathematics Participation (Course-Taking)
- B. Type of School Program
- C. Grades in Mathematics

IX. Achievement in Mathematics

- A. Computation
- B. Algebra
- C. Problem Solving
- D. Spatial Visualization

X. Background Variables

- A. Sex
- B. Age
- C. Race
- D. Socioeconomic Status
- E. Parental Education
- F. Parental Occupations

I.A. General Sex-Role Stereotyping

1. If a man and a woman are equally qualified for a job, the man should get hired. (I-3)
2. I would never vote for a woman to be president of the United States, even if she were well qualified. (I-7)
3. A college education is more important for boys than for girls. (I-20)
4. Married women should work only if their families need the money. (I-29)
5. It is possible for a woman to have a successful career and be a good wife and mother. (I-33)
6. If a girl plans to get married, she does not need to think about a career. (III-8)
7. If I marry, I want the husband to work and the wife to take care of the home and family. (III-14)
8. A mother should not have a job while her children are young. (III-18)
9. A woman can be very successful in a career and still have an interesting social life. (III-24)
10. A wife's professional career is as important as her husband's. (III-29)

Hoyt Reliability Coefficients

	Male	Female
Grade 8	.79	.79
Grade 11	.86	.86

I.B. Mathematics as a Male Domain

1. Just as many women could be good scientists or engineers as men. (1-5)
2. Men need to know more mathematics than women. (I-8)
3. Girls can do just as well as boys in mathematics. (I-14)
4. Women do not do as well as men in jobs that use a lot of mathematics. (I-17)
5. Fewer females than males have the logical ability to become mathematicians. (I-30)
6. Men are naturally more able than women in scientific and technical fields. (I-35)
7. I would expect a female mathematician to be somewhat masculine. (Masculine means looking or acting like men.) (III-1)
8. Mathematics is more for males than for females. (III-12)

Hoyt Reliability Coefficients

	Male	Female
Grade 8	.79	.78
Grade 11	.82	.82

I.C. Men's Attitudes Toward Women Who Are Successful in Mathematics

1. Most men would prefer to work with other men as colleagues or associates. (I-13)
2. A man would probably feel uncomfortable around a woman who is a "brain" in mathematics or science. (I-26)
3. Men do not like to date women who are good in mathematics. (I-40)
4. Most men would NOT want to marry a woman interested in becoming a scientist or mathematician. (III-3)
5. Women who are good in mathematics do not generally appeal to men. (III-6)
6. Women who are good in mathematics tend NOT to be very feminine. (III-30)

II.A. Career Aspirations

1. What job or career do you plan to have? Write the name of your career in the space provided on the answer sheet. (X-14)

2. Look at the groups of careers below. In which group of careers does yours belong? Mark the letter of the group on your answer sheet. You may not find your exact career listed, but mark the one group in which you think it would fall. (X-16)

   A. ARTISTS AND ENTERTAINERS--such as a writer, journalist, artist, musician, actor/actress, designer, professional athlete, etc.

   B. CLERICAL, TECHNICAL AND SERVICE PERSONNEL--such as a bank teller, sales clerk, office worker, dental or medical technician, draftsman, computer programmer, policeman/policewoman, fireman, postal worker, nurse, etc.

   C. EXECUTIVES--such as a president or vice president of a large company, banker, government official or district manger, etc.

   D. HOMEMAKER

   E. MANAGEMENT AND MARKETING PERSONNEL--such as a store manager, insurance agent, owner of a small business, restaurant owner, real estate agent, sales representative, military officer, contractor, airline pilot, etc.

   F. PROFESSIONALS--such as a doctor, lawyer, teacher, librarian, social worker, accountant, architect, physicist, minister, vetinarian, forester.

   G. SEMI-SKILLED WORKERS--such as a factory machine operator, keypunch operator, truck driver, factory worker, security guard, farm worker, waiter/waitress, cab or bus driver, laborer, gas station attendant, etc.

   H. SKILLED WORKERS--such as a carpenter, plumber, mechanic, enlisted military person, farmer, tool and die worker, butcher, flight attendant, etc.

   I. I don't know.

II.B. Mathematics Preparation Required for a Job

How much mathematics do you think is needed to get into the career you have chosen?

A. None
B. Some high school mathematics
C. Four years of high school mathematics
D. Some college mathematics
E. A lot of college mathematics

II.C. Factors Influencing Career Choice

When the time comes for you to choose a career (careers would include homemaking as well as other occupations), how important will each of the following factors be in your decision about taking a particular job? The answer choices are "Not Important at All", "Not Important", "Undecided", "Important", and "Very Important." (X-1-11)

		Not Important At All	Not Important	Undecided	Important	Very Important
1.	What your mother thinks	A	B	C	D	E
2.	What your father thinks	A	B	C	D	E
3.	What your future husband or wife would think	A	B	C	D	E
4.	What your school counselor thinks	A	B	C	D	E
5.	What your teachers think	A	B	C	D	E
6.	Whether you could do the job well	A	B	C	D	E
7.	Whether you would enjoy the job	A	B	C	D	E
8.	Whether it is an important job	A	B	C	D	E
9.	Whether the job is traditionally done only by men or only by women	A	B	C	D	E
10.	Amount of education needed for the job	A	B	C	D	E
11.	Amount of mathematics needed for the job	A	B	C	D	E

Suppose a job you were considering would require you to use some mathematics. How would this affect your decision about taking the job? Choose only one answer. (X-12)

A. It would definitely be a reason for me to take the job.
B. It might be a reason for me to take the job.
C. It would not matter to me.
D. It might be a reason for me NOT to take the job.
E. It would definitely be a reason for me NOT to take the job.

Suppose a job you were considering were a job normally done by members of the opposite sex. How would this affect your decision about taking the job? Choose only one answer. (X-13)

A. It would definitely be a reason for me to take the job.
B. It might be a reason for me to take the job.
C. It would not matter to me.
D. It might be a reason for me NOT to take the job.
E. It would definitely be a reason for me NOT to take the job.

III.A. Confidence in Mathematics

1. Mathematics is easier for me than it is for most people. (I-1)
2. I am not very good at working mathematics problems. (I-18)
3. I am confident in mathematics. (I-31)
4. I just cannot understand mathematics. (I-34)
5. I usually feel confident when taking mathematics tests. (I-36)
6. I am very proud of my mathematics school work. (I-38)
7. I can get good grades in mathematics. (III-7)
8. I am no good in mathematics. (III-16)

Hoyt Reliability Coefficients

	Male	Female
Grade 8	.84	.91
Grade 11	.85	.93

III.B. Anxiety in Mathematics

1. Mathematics does not scare me at all. (I-19)
2. I dread mathematics class. (I-24)
3. Mathematics teachers make me more nervous than other teachers. (I-25)
4. I usually do not worry about mathematics. (I-32)
5. Taking mathematics tests scares me. (III-5)
6. Working mathematics problems makes me tense. (III-17)
7. I usually have been at ease during mathematics tests. (II-22)
8. I am usually at ease in mathematics class. (III-27)
9. Doing mathematics problems is usually frustrating. (III-28)
10. I dread being called on in mathematics class. (III-32)

Hoyt Reliability Coefficients

	Male	Female
Grade 8	.82	.88
Grade 11	.90	.93

III.B. Anxiety in School

1. Taking tests in school scares me. (I-2)
2. School classes do not scare me at all. (I-6)
3. I am usually at ease in school classes. (I-21)
4. Doing schoolwork makes me feel tense. (III-4)
5. Schoolwork is usually frustrating. (III-21)

Hoyt Reliability Coefficients

	Male	Female
Grade 8	.62	.73
Grade 11	.71	.80

III.B. Anxiety in English

1. I am usually at ease in English class. (I-11)
2. English assignments are usually frustrating. (I-15)
3. Taking tests in English class scares me. (I-23)
4. Doing English assignments makes me feel tense. (I-28)
5. English class does not scare me at all. (III-15)
6. I dread English class. (III-25)

Hoyt Reliability Coefficients

	Male	Female
Grade 8	.67	.77
Grade 11	.73	.88

III.C. Enjoyment of Mathematics

1. Working with numbers is fun. (I-4)
2. I have never liked mathematics. (I-27)
3. I enjoy mathematics classes. (I-37)
4. Mathematics fascinates me. (III-2)
5. Solving mathematics problems is boring. (III-9)
6. Solving a hard mathematics problem is exciting. (III-11)
7. I do not enjoy working mathematics problems. (III-19)
8. I would like to spend more time in school doing mathematics. (III-26)

Hoyt Reliability Coefficients

	Male	Female
Grade 8	.88	.90
Grade 11	.86	.90

IV. Usefulness of Mathematics to the Individual

1. I need to know basic arithmetic, but I will not need to know any more mathematics than that. (I-9)
2. Taking mathematics is a waste of time for me. (I-12)
3. I will use mathematics in many ways as an adult. (I-16)
4. I probably will not need mathematics in my future work. (I-22)
5. Knowing mathematics will help me better understand the world about me. (I-39)
6. Mathematics is useful in my daily life. (III-10)
7. Not taking high school mathematics would seriously limit jobs that are available to me. (III-13)
8. Mathematics is important to my future educational plans. (III-20)
9. I cannot see how mathematics will be very useful to me outside of school. (III-23)
10. Knowing mathematics will help me get a good job. (III-31)

Hoyt Reliability Coefficients

	Male	Female
Grade 8	.82	.82
Grade 11	.86	.88

V.A. Educational Aspirations

What is the highest level of education you expect to complete? (II-3)--Age 13; (II-15)-- Grade 12

A. High school
B. Vocational, trade or technical school
C. Two-year college
D. Four-year college or university
E. Graduate or professional school after college

V.B. Taking more Mathematics-- Age 13

In the four years from grades nine through twelve, how many years do you think you might take mathematics? (II-1)

A. None
B. 1 year
C. 2 years
D. 3 years
E. 4 years

V.C. Factors Influencing the Decision to Take More Mathematics--Age 13

How important will each of the following factors be in deciding whether or not you take more mathematics courses in high school than are required? The answer choices are "Not Important At All," "Not Important," "Undecided," "Important" and "Very Important." (VIII-36-44)

	Not Important At All	Not Important	Undecided	Important	Very Important
1. What your mother thinks	A	B	C	D	E
2. What your father thinks	A	B	C	D	E
3. What your school counselor thinks	A	B	C	D	E
4. What your mathematics teachers think	A	B	C	D	E
5. How much you like or dislike mathematics	A	B	C	D	E
6. How good or bad you are in mathematics	A	B	C	D	E
7. How useful you think mathematics will be in getting into college or getting a job	A	B	C	D	E
8. Whether you friends take mathematics	A	B	C	D	E
9. Whether your classmates approve of people who take a lot of mathematics	A	B	C	D	E

V.C. Factors Influencing the Decision to Take More Mathematics--Grade 12

How important was each of the following factors in deciding whether or not you took more mathematics courses in high school than are required? The answer choices are "Not Important At All," "Not Important," "Undecided," "Important," and "Very Important." (VIII-36-44)

	Not Important At All	Not Important	Undecided	Important	Very Important
1. What your mother thought	A	B	C	D	E
2. What your father thought					
3. What your school counselor thought					
4. What your mathematics teachers thought					
5. How much you liked or disliked mathematics					
6. How good or bad you were in mathematics					
7. How useful you thought mathematics would be in getting into college or getting a job					
8. Whether your friends took mathematics					
9. Whether your classmates approved of people who take a lot of mathematics					

VI.A. Father as Role Model

1. My father likes mathematics. (VI-11)

2. My father is good in mathematics. (VI-19)

3. How often does your father use mathematics? (VI-25)

   A. Often
   B. Sometimes
   C. Rarely
   D. Never

Hoyt Reliability Coefficients

	Male	Female
Grade 8	.64	.61
Grade 11	.67	.77

4. Who uses more mathematics in your home? (VI-24)

   A. Your mother
   B. Your father
   C. Both your mother and father about the same

VI.A. Mother as Role Model

1. My mother likes mathematics. (VI-12)

2. My mother is good in mathematics. (VI-20)

3. How often does your mother use mathematics? (VI-26)

   A. Often
   B. Sometimes
   C. Rarely
   D. Never

Hoyt Reliability Coefficients

	Male	Female
Grade 8	.64	.61
Grade 11	.60	.73

4. Who uses more mathematics in your home? (VI-24)

   A. Your mother
   B. Your father
   C. Both your mother and father about the same

VI.B. Father's Encouragement in Mathematics

1. My father thinks advanced mathematics is a waste of time for me. (VI-3)
2. My father has not seemed to care how well I do in mathematics. (VI-5)
3. My father expects me to do well in mathematics. (VI-7)
4. My father has encouraged me to take all the mathematics I can. (VI-9)
5. My father has made me feel I could be good in mathematics. (VI-13)
6. My father thinks mathematics is important to my future. (VI-15)
7. My father has always been interested in my progress in mathematics. (VI-17)
8. My father has made me feel that I have the ability to go on in mathematics. (VI-21)

Hoyt Reliability Coefficients

	Male	Female
Grade 8	.80	.80
Grade 11	.83	.85

VI.B. Mother's Encouragement in Mathematics

1. My mother thinks advanced mathematics is a waste of time for me. (VI-4)
2. My mother has not seemed to care how well I do in mathematics. (VI-6)
3. My mother expects me to do well in mathematics. (VI-8)
4. My mother has encouraged me to take all the mathematics I can. (VI-10)
5. My mother has made me feel I could be good in mathematics. (VI-14)
6. My mother thinks mathematics is important to my future. (VI-16)
7. My mother has always been interested in my progress in mathematics. (VI-18)
8. My mother has made me feel that I have the ability to go on in mathematics. (VI-22)

Hoyt Reliability Coefficients

	Male	Female
Grade 8	.89	.87
Grade 11	.78	.84

VI.C. Parents Stereotyping of Mathematics

1. My father thinks mathematics is more for males than for females. (VI-1)

2. My mother thinks mathematics is more for males than for females. (VI-2)

VI.D. Parents Helping with Homework

Who has helped you more with your mathematics homework? (VI-23)

A. Your father
B. Your mother
C. Your father and mother about equally
D. Neither of your parents has helped you

VI.E. Parents' Educational Expectations for Offspring

1. What is the highest level of education your father expects you to complete? (VI-27)

   A. High school
   B. Vocational, trade or technical school
   C. Two-year college
   D. Four-year college or university
   E. Graduate or professional school after college
   F. I don't know.

2. What is the highest level of education your mother expects you to complete? (VI-28)

   A. High school
   B. Vocational, trade or technical school
   C. Two-year college
   D. Four-year college or university
   E. Graduate or professional school after college
   F. I don't know.

VI.F. Family Status

1. With which adult or adults do you live? (VIII-31)

   A. Just your father
   B. Just your mother
   C. Both your parents (or guardians)
   D. Other

2. If you live with only one parent, do you see your OTHER parent often? (VIII-32)

   A. Yes
   B. No
   C. I live with both parents (or guardians)

VII.A. Peer Influence

1. If I got a high grade on a mathematics test, I would not mind if my friends knew it. (VIII-4)
2. My friends think mathematics is a waste of time. (VIII-5)
3. I do not like to appear too smart in mathematics. (VIII-6)
4. My friends look down on people who get good grades in mathematics. (VIII-9)
5. If I got good grades in mathematics, I would try to hide it. (VIII-12)
6. I would NOT want someone who is good in mathematics as my best friend. (VIII-14)
7. There are times when I feel I should play "dumb" in mathematics. (VIII-17)
8. I would like my friends to think I am smart in mathematics. (VIII-22)
9. People would like me less if I were a really good mathematics student. (VIII-26)
10. Many of my friends are good in mathematics. (VIII-27)

Hoyt Reliability Coefficients

	Male	Female
Grade 8	.66	.72
Grade 11	.79	.81

VII.B. Peer Stereotyping of Mathematics

1. The boys among my friends think mathematics is more for males than for females. (VIII-1)
2. The girls among my friends think mathematics is more for males than for females. (VIII-15)

VII.C. Counselor Encouragement to Take More Mathematics

Which one of the following statements best describes your experience with a school counselor? The counselor (VIII-35)

A. strongly encouraged me to take more mathematics than was required to graduate.

B. encouraged me to take more mathematics than was required to graduate.

C. did not care if I took more mathematics than was required to graduate.

D. discouraged me from taking more mathematics than was required to graduate.

E. strongly discouraged me from taking more mathematics than was required.

F. has never counseled me about mathematics.

VII.D. Teacher Encouragement in Mathematics

1. My mathematics teachers have NOT been interested in my progress in mathematics. (VIII-2)
2. My mathematics teachers have expected me to do well in mathematics. (VIII-3)
3. My mathematics teachers have discouraged me from taking more mathematics.((VIII-7)
4. Mathematics teachers have made me feel that I have the ability to go on in mathematics. (VIII-10)
5. My mathematics teachers have made me feel I could be good in mathematics. (VIII-18)
6. My mathematics teachers have been willing to give me individual help (if I needed it). (VIII-21)
7. My mathematics teachers think advanced mathematics is a waste of time for me. (VIII-24)
8. My mathematics teachers have encouraged me to take all the mathematics I can. (VIII-29)

Hoyt Reliability Coefficients

	Male	Female
Grade 8	.80	.84
Grade 11	.82	.88

VII.E. Teacher Stereotyping of Mathematics

1. Mathematics teachers think mathematics is more for males than for females. (VIII-28)

VII.F. Teacher Differential Treatment

1. Mathematics teachers treat the girls the same as the boys in mathematics. (VIII-8)
2. Mathematics teachers expect girls to do as well as boys in mathematics. (VIII-11)
3. Mathematics teachers usually call on girls in class as much as boys. (VIII-13)
4. Mathematics teachers encourage girls as much as boys to do well in mathematics. (VIII-16)
5. Mathematics teachers expect boys to do better in mathematics than girls. (VIII-19)
6. Mathematics teachers usually encourage boys more than girls to do well in mathematics. (VIII-20)
7. Mathematics teachers enjoy teaching boys more than girls. (VIII-23)
8. Mathematics teachers usually call on boys in class more than girls. (VIII-25)
9. Mathematics teachers enjoy teaching girls as much as boys. (VIII-30)
10. Mathematics teachers think mathematics is more for males than for females. (VIII-28)

Hoyt Reliability Coefficients

	Male	Female
Grade 8	.82	.77
Grade 11	.88	.86

VII.G. Sibling Role Models

1. Do you have an older brother who is good in mathematics? (VIII-33)
   A. I have an older brother who IS good in mathematics.
   B. I have an older brother who is NOT good in mathematics or I do not have an older brother. (VIII-33)
2. Do you have an older sister who is good in mathematics? (VIII-34)
   A. I have an older sister who IS good in mathematics.
   B. I have an older sister who is NOT good in mathematics or I do not have an older sister.

VIII.A. Mathematics Participation--Age 13

Did you take (or are you now taking) Algebra I while in the eighth grade?

A. Yes
B. No
C. I am not yet in the eighth grade.

VIII.A. Mathematics Participation--Grade 12

When answering the questions on this page, if you are presently enrolled in a course that is named, answer "Yes" even though you have not yet completed that course. (II-1-13)

1.	Have you completed a course in General Mathematics?	Yes	Np
2.	Have you completed a course in Accounting or Business Mathematics?	Yes	No
3.	Have you completed a course in Consumer Mathematics?	Yes	No
4.	Have you completed a course in Pre-Algebra?	Yes	No
5.	Have you completed a course in Algebra I?	Yes	No
6.	Have you completed a course in Geometry?	Yes	No
7.	Have you completed a course in Algebra II?	Yes	No
8.	Have you completed a course in Trigonometry or a course in which Trigonometry was a major part?	Yes	No
9.	Have you completed a course in Probability or Statistics?	Yes	No
10.	Have you completed a course in Computer Programming?	Yes	No
11.	Have you completed a course in Pre-Calculus? (e.g., advanced or senior mathematics, analytical geometry, elementary functions, advanced or college algebra, mathematics analysis)	Yes	No
12.	Have you completed a course in Calculus?	Yes	No
13.	Did you take Algebra I while you were in the eighth grade?	Yes	No

VIII.B. Type of School Program--Grade 12

How would you classify the primary emphasis of your high school courses? (II-14)

A. General
B. Vocational, technical or trade
C. College preparatory

VIII.C. Grade in Mathematics

Which one of the following best describes the grades you have gotten in mathematics? (II-2)--Age 13; (II-16)--Grade 12

A. Excellent or A or (90%-100%)
B. Good or B or (80%-89%)
C. Average or C or (70%-79%)
D. Fair or D or (60%-69%)
E. Poor or Failing or F or (Below 60%)

X.D.E.F. SES, Parental Education and Parental Occupations

1. In which group of careers does your father's occupation belong? Use the same list you just used on number 16 and mark the letter of the group on your answer sheet. You may not find your father's exact career listed, but mark the one group in which you think it would fall. (X-17)

2. In which group of careers does your mother's occupation belong? Use the same list you just used on numbers 16 and 17 and mark the letter of the group on your answer sheet. You may not find your mother's exact career listed, but mark the one group in which you think it would fall. (X-18)

3. Which one of the following best describes the highest level of education your father completed? (X-19)

   A. Did not graduate from high school
   B. Graduated from high school
   C. Completed one to three years of study after high school
   D. Graduated from a four-year college or university
   E. Attended a graduate or professional school after college
   F. I don't know.

4. Which one of the following best describes the highest level of education your mother completed? (X-20)

   A. Did not graduate from high school
   B. Graduated from high school
   C. Completed one to three years of study after high school
   D. Graduated from a four-year college or university
   E. Attended a graduate or professional school after college
   F. I don't know.

X.D.E.F. SES, Parental Education and Parental Occupations (Cont'd.)

Do you have the following items in your home? (X-21-31)

A.	A specific place for study	Yes	No
B.	Daily newspaper	Yes	No
C.	Dictionary	Yes	No
D.	Encyclopedia or other reference books	Yes	No
E.	Magazines	Yes	No
F.	Record player	Yes	No
G.	Tape recorder or cassette player	Yes	No
H.	Color television	Yes	No
I.	Typewriter	Yes	No
J.	Electric dishwasher	Yes	No
K.	Two or more cars or trucks that run	Yes	No

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APPENDIX A

Consultants

Advisory Board

Lorelei Brush	ABT Associates, Cambridge, MA
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James W. Wilson	University of Georgia, Athens, GA

Reviewers

Norma J. Anderson	University of Massachusetts, Amherst, MA
Susan Auslander	Wesleyan University, Middletown, CT
Iris Carl	Houston Independent School District, Houston, TX
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Elizabeth Fennema	University of Wisconsin, Madison, WI
Roberta Flexer	University of Colorado, Boulder, CO
Norris Harms	University of Colorado, Boulder, CO
Norma Hernandez	University of Texas at El Paso, El Paso, TX
Peggy Hawley	San Diego State University, San Diego, CA
Edward Kiefer	University of Kentucky, Lexington, KY
Nancy Kreinberg	Lawrence Hall of Science, Berkeley, CA
Alma Lantz	Denver Research Institute, Denver, CO
Margaret Rogers	Yakima School District, Yakima, WA
Lucy Sells	University of Maryland, College Park, MD
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Sheila Tobias	Wesleyan University, Middletown, CT
Anita West	Denver Research Institute, Denver, CO

APPENDIX B

Source Documentation for Cognitive Items

Test Section IV--Computation

Items from the Stanford Achievement Test, Form A, Advanced. Harcourt, Brace, Jovanovich, Inc., 1972. Test 4, Mathematics Computation, Part B.

The items, in the order they appear in the survey booklet are:
20, 25, 26, 27, 30, 31, 34, 37, 38, 39, 41, 42, 44, 33

Test Section V--Problem Solving

Items from the Metropolitan Achievement Tests, Advanced, Form F. Harcourt, Brace, Jovanovich, Inc., 1970. Test 7, Mathematics Problem Solving.

The items, in the order they appear in the survey booklet are:
1, 4, 9, 12, 21, 22, 25, 26, 27, 29

Items from the Metropolitan Achievement Tests, Form BM. Harcourt, Brace, Jovanovich, Inc., 1963. Test 9, Mathematical Analysis and Problem Solving.

The last two items of these final four in the Problem Solving section were for the grade 12 sample only:
3, 7, 10, 26

Test Section VII--Algebra

Items from the Cooperative Mathematics Tests, Form A, Algebra I. Educational Testing Service, 1962.

The items, in the order they appear in the survey booklet are:
8, 20, 5, 13, 32, 2*, 18, 21, 22, 9, 16, 29, 36, 30, 31, 34

Test Section IX--Space Relations

Items from the Revised Minnesota Paper Form Board, Series AA. The Psychological Corporation, 1969.

The items, in the order they appear in the survey booklet are:
4, 6, 9, 18, 63, 27, 30, 31, 32, 37, 44, 45, 51, 49, 50

*Only the first six algebra items were administered to the thirteen-year-old sample.

APPENDIX C

Source Documentation for Attitude Items

Sources are indicated by variable and item number as they appear on pages 22-39 of this report.

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Dutton, W. "Prospective Elementary School Teachers Understanding of Arithmetic Concepts." Journal of Educational Research, 58 (8), 1965.	III.C.-1
Sandman, Richard. "The Development, Validation and Application of a Multidimensional Mathematics Attitude Instrument." Ph.D. dissertation, University of Minnesota, 1972.	III.A.-2, III.C.-8
Wilson, J. W., Cahen, L. S. and Begle, E. G. (Eds.). Z-Population Test Batteries (NLSMA Report No. 3) Stanford, CA: School of Mathematics Study Group, 1958.	III.A.-6
Rocky Mountain Educational Laboratory, Inc. "Occupational Educational Program--Image of the World of Work."	I.A.-6
Stright, Virginia. "A Study of Attitudes Toward Arithmetic of Students and Teachers in the Third, Fourth and Sixth Grades." Arithmetic Teacher 7 (6), 1960.	IV.-9